United Nuclear Corporation Air Concentration Data for 1961 and 1962

Lara Hughes
NIOSH/DCAS
November 2011

The problem:

Routine bioassay sampling was done for workers at the United Nuclear Corp. facility through its entire covered period with the exception of 1961 and most of 1962. Bioassay sampling was stopped by 1961 for mostly economic reasons and because it was thought that exposure levels had been established. Bioassay sampling was restarted in December of 1962, when it turned out that some workers had significant intakes of radioactive material. To do dose reconstruction for 1961 and 1962, NIOSH relies on extrapolated urine bioassay information from years prior to 1961 (see Battelle TBD-6001, Appendix D) with the assumption that the this is a claimant friendly approach as opposed to using the available air sampling data for this period. During work group discussions SC&A has raised doubt that the air sample data from 1961-1962 support the approach used by NIOSH.

The following paper shows:

1) Air sample data is available through the entire "gap period" from January 1961 through December of 1962.
2) Air sample data largely correlates with the activities at the plant (i.e. exposure heavy activities were monitored)
3) Intakes calculated from bioassay are more claimant friendly than intakes derived from air data

1. Available air sample data for 1961 and 1962

Air sample data from 1961 and 1962 are available for various operations, persons and areas, including the operations that caused the highest exposure in the workers when bioassay samples were collected (the highly enriched uranium work in the Red Room). Table 1 gives an overview of the available data.

1961:

- 310 air samples (GA/BZ/SS), results available for every month of the year for 1961, except December. Locations, dates and type of sample are noted on the sample sheets.
- Summary report of worker exposures to air contamination for 132 workers, no work locations are indicated, (Ref ID: 062179).

1962:

- 171 (GA/BZ/SS) air samples, results are available for every month of the year except December. Locations, dates and type of sample are noted on the sample sheets.
- Two sets of personal exposure records containing worker specific air sample data from April to December and July to December of 1962 respectively (total of 58 data points), (Ref ID: 062172).
- Results of a specific "dust study" from the Pellet Plant in February of 1962 (a total of 58 data points were collected, but the report only contains averages, minimum and maximum values), (Ref ID: 062306)
- Integrated dust exposure results for workers. Dates range from January 1962 through December 1962 and represent weekly dust exposure results for individual workers in μCi/ml of alpha activity. Each result sheet has data for about 90 workers each week totaling to 1787 data points, representing 20 weekly periods in 1962 (Ref ID 062179). No sample locations available, although some high readings indicate type of work or location by handwritten note.

Locations:

General Air, Breathing Zone and Source Sample air samples were collected in the following locations:

- Red room, at various operations and locations (Ref ID: 062276)
- Green room, various locations and operations (Ref ID: 062283)
- Blue Room, various locations and operation (Ref ID: 062328, 062340)
- Item 1 plant various locations (Ref ID: 062285)
- Pellet Plant, various locations (Ref ID: 062285, 062328, 062287)
- Laundry area (Ref ID: 062171)
- Warehouse area (Armco warehouse), various locations (Ref ID: 062171)
- Blender room, various locations (Ref ID: 062282)
- Guard Station (Ref ID: 062171)
- Office area (Ref ID: 062171)

Table 1. Air sample data points available for each location

Location	1961 # data points	1962 # data points	Illegible date (but likely '61 or '62)
Red Room	104	21	15
Green Room	36	4	
Blue Room	73	93	
Blender Room	3	4	
Item #1 plant	29	7	
Pellet Plant	41	95	
Armco Warehouse	14	0	
Guard Station	0	3	
Office	0	3	
Laundry	5	0	
Unknown area	5	0	
Integrated personal dust exposure	132*	1847*	
Total	**442**	**2077**	**15**

* These are reported as personal exposure results in µCi/ml. It is not clear how they were calculated; I assume that they may have been derived from GA or BZ samples in the workers' area.

2. Air sample data correlate with the activities at the plant (i.e. exposure heavy activities were monitored)

The following section focuses on the available general air, breathing zone and source sample data sets and do not include the integrated personal exposure data, since those do not include location information.

The Red Room was the area where operations with highly enriched uranium took place, and where high worker exposures were measured when in 1962. It was determined that workers were acquiring large amounts of contamination on their hands from handling uranium without gloves (Ref ID 011724, page 54, Ref ID 062316, pg. 2). During the time period when no bioassay sampling took place, the Red Room was the location where many air samples were collected. After the bioassay sampling was reinstated in 1962, it was found that a few of the Red Room workers had received some significant intakes, so it is reasonable to assume that the Red Room operations were the ones with the highest exposure potential for the workers.

The Administrative Control Level (ACL) for alpha radioactivity in air during the 1961-1962 period was 110 dpm/m^3 for operations involving "normal" uranium (up to 2 % enriched) and 220 dpm/m^3 for uranium enriched > 2 % (Ref ID 062306). Table 2 lists the air concentration results above 220 dpm/m^3. Of the 37 measurements that were above the ACL of 220 dpm/m^3, ten (27 %) were measured in the Red Room and an additional 14 were measured in other areas where

enriched (> 2 %) uranium was handled (Blue Room, Item Plant, Pellet Plant, Green Room). This number could be misleading, since the sample sheets don't always mention the enrichment factor of the material being handled. Additional locations were the ACL was exceeded were the Blender Room, the Pellet Plant and the Laundry Area, where presumably contaminated clothing was handled and washed. The highest sample of 35520 dpm/m^3 is from an unknown location (Illegible entry) and has an explanation written on the data sheet, which is also illegible.

Table 2. Locations and air concentration values above ACL for enriched uranium

Sample Number	Sample Date	SRDB Ref ID	Location/activity	Result (dpm/m^3)
95	2/17/1961	62171	unknown, some operation, BZ	35520
85	4/4/1962	62340	Blue Room, Wet Bay operations, 2.2 %, BZ	27600
84	4/4/1962	62340	Blue Room, hydrolysis operations, BZ	10307
52	1/26/1961	62283	Green Room, misc. ops, BZ	1043
47	1/11/1961	62340	Blue Room, Recovery ops 3.5, BZ	1013
206	3/31/1961	62328	BZ 93 % shot, Blue Room R&D, BZ	952
205	3/31/1961	62328	BZ 93 % shot, Blue Room R&D, BZ	938
96	2/17/1961	62171	unknown, some operation, GA	910
160	6/26/1962	62276	Red Room, at UF6 conversion hood, GA	906
?	1/11/1961	62340	Blue Room, Recovery ops 3.5, BZ	875
370	7/31/1961	62276	Red Room during demolition of hydrolysis hood, cont. on floor, 12" west of hood, GA	686
371	7/31/1961	62276	Red Room during demolition of hydrolysis hood, mill and sift hood, GA	635
80	4/4/1962	62340	Blue Room, Wet Bay operations, 2.2 %, BZ	578
81	4/4/1962	62340	Blue Room, hydrolysis operations, BZ	517
1	1/9/1962	62328	Blue Room, GA at side Bink's hood, R&D annex, GA	515
162	3/22/1961	62171	Laundry operations, sorting clothes in washer, BZ	480
133	5/9/1962	62276	Red Room, UF_4 ops, unloading ? Reactor, GA	444
51	1/26/1961	62283	Green Room, misc. ops, BZ	422
29	1/13/1961	62283	Green Room, 4.8 %, GA	400
232	4/19/1961	62276	Red Room , direct green, 93 % UF_6/UF_4, BZ	319
372	7/31/1961	62276	Red Room during demolition of hydrolysis hood, cont. on floor, 12" west of hood, GA	311
49	1/23/1961	62340	Blue Room, Recovery ops 3.05, BZ	305
345	6/22/1961	62276	Red Room, 93 % operations, UF4…, GA	300
23	2/13/1962	62287	over outlet […] vac. Cleaner, SS	295
59	2/6/1961	62171	S. Bay pellet plant, welding area top of large reactor, GA	289
278	5/23/1961	62276	Red Room, processing 93% material, Station 2 in front of pyro furnaces, GA	280

Sample Number	Sample Date	SRDB Ref ID	Location/activity	Result (dpm/m^3)
59	2/2/1961	62282	Blender Room, using U_3O_8 (3.05), BZ	266
455	10/5/1961	62285	Item #1 plant, using 93 % feed, GA/BZ	266
456	10/5/1961	62285	Item #1 plant, using 93 % feed, GA/BZ	266
169 (?)	5/10/1962	62282	Blender Room, 3.0 %, BZ	266
373	7/31/1961	62276	Red Room during demolition of hydrolysis hood, mill and sift hood, GA	262
39	2/16/1962	62287	PP, grinding 2.4 % pellets, BZ	254
459	10/5/1961	62285	Item #1 plant, using 93 % feed, GA/BZ	244
163	3/22/1961	62171	Laundry operations, wet clothing bin, GA	225
3	10/19/1962	62287	PP, while putting in new press,	224
460	10/5/1961	62285	Item #1 plant, using 93 % feed, GA/BZ	222
281	5/23/1961	62276	Red Room, processing 93% material, Station 2 in front of pyro furnaces, GA	222

3. Intakes calculated from bioassay are more claimant friendly than intakes derived from air data

The available air sample data sets from 1961 and 1962 were fit to a lognormal distribution and the geometric mean (GM) and geometric standard deviation (GSD) were derived from the data. Separate analyses were done for the GA/BZ/SS data set and the integrated personal exposure data set. A separate analysis was also done using data for only the Red Room. The entire data set has a GM of 20.3 dpm/m^3 and a GSD of 4.8. The data only for the Red Room has a GM of 32.2 dpm/m^3 and a GSD of 3.4. Using the 1961 and 1962 worker exposures air date (Ref ID 062179), the GM is 35.8 dpm/m^3 and the GSD is 2.

Potential worker intakes were calculated by using the GM values and assuming a daily inhalation rate of 9.6 m^3/d (assumes an 8 hour workday). The table below lists the daily intake values derived from the air sample data as well as the intake data derived from Battelle TBD-6001, Appendix D, which is what is currently used for dose reconstructions.

Table 3. Comparison of derived intake values from air concentration data vs. bioassay data

Data Set	N (# data points)	GM (GSD) daily intake from air sample (dpm/d)	95th percentile, daily intake from air sample (dpm/d)	TBD-6001 App.D intake (dpm/d)[a)]
All locations	491	**195** (4.8)	2555	Operators: **12590** (Type S) **871.9** (Type M)
Red Room only	243	**309** (3.4)	2304	
Worker data	1921	**344** (2.0)	1034	Supervisors/Other **4784** (Type S) **331.2** (Type M)

a) See Battelle-TBD-6001; Appendix D, Table D.1, intake values represent the GM of a lognormal distribution derived from bioassay results.

Table 3 shows that the intakes derived from the air data collected during 1961 and 1962 are much lower that the intakes derived from the urine bioassay from years prior to 1961 and that the intakes presented in the current TBD are bounding when compared to the air sample data.

References

Air Sample Data, 1961, *Air Sample Data Sheet –United Nuclear Corporation*; AEC Health and Safety Laboratory; August 1961; SRDB Ref ID: 7105

Air Sample Data, 1961-63, *Air Sample Data Sheet –United Nuclear Corporation*; Mallinckrodt Chemical Works; various dates in 1961-63; SRDB Ref ID: 62285

Air Sample Data, 1961-63, *Air Sample Data Sheet –United Nuclear Corporation*; Mallinckrodt Chemical Works; various dates in 1961-63; SRDB Ref ID: 62285

Assorted Results, 1963, Assorted Air and Contamination Study Results, United Nuclear Corporation; various dates in 1963; SRDB Ref ID: 62276

Battelle-TBD-6001, Appendix D, *Site Profiles for Atomic Weapons Employers that Refined Uranium and Thorium—Appendix D United Nuclear Corp.*, Rev. 0; Battelle; March 14, 2008; SRDB Ref ID: 41835

Blending Room, 1961-63, Blending Room Air Sample Data, United Nuclear Corporation; various dates in 1961-1963; SRDB Ref ID: 62282

Blue Room, 1960-63, Various Air Sample Data Sheets, Mallinckrodt Chemical Works; various dates 1960-1963; SRDB Ref ID: 62328

Blue Room, 1962-63, Various Air Sample Data Sheets, Mallinckrodt Chemical Works; various dates 1962-1963; SRDB Ref ID: 62340

Dust Exposure, 1962, *United Nuclear Corporation Integrated Dust Exposure*, United Nuclear Corporation; various dates in 1962; SRDB Ref ID: 62179, pdf pp. 7-54

Estimated Exposures, 1963, *Estimated Lung Exposures for Entire Year, 1963*, letter from J. A. Lindberg (V.P., UNC) to C. Keller (AEC); United Nuclear Corporation; October 28, 1963; SRDB Ref ID: 62316

Green Room, 1961-63, *Green Room Air Sample Data*, Mallinckrodt Chemical Works; various dates in 1961-63; SRDB Ref ID: 62283

Non-process Air Samples, 1961-63, Lunchroom, Armco Warehouse, and Other Locations Air Samples, United Nuclear Corporation; various dates in 1961-1963; SRDB Ref ID: 62171

Pellet Plant, 1961-62, *Pellet Plant Air Sample Data, Hematite, Mo.*, Mallinckrodt Chemical Works; various dates in 1961-62; SRDB Ref ID: 62287

Pellet Plant, 1961-62, *Pellet Plant Air Sample Data, Hematite, Mo.*, Mallinckrodt Chemical Works; various dates in 1961-62; SRDB Ref ID: 62287

Uranium Dust, 1962, *Uranium Dust Study of Pellet Plant Operations – Bldg. 255-2*, United Nuclear Corporation; October 1962; SRDB Ref ID: 62306

Various authors, 1963, *UNC Bioassay Program Information and Some Results for 4-19-63 to 11-4-63*; various authors; SRDB Ref ID: 11724